# Programmable Camera Module as a Distance Viewing of Live Power Line 20 KV-Hand Robotic

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**Abstract.** Electrical energy is a very important requirement for life, almost all life activities require electrical energy. The live line voltage installation of the insulator cover on the strain clamp 20 KV system is done by a hand robotic is a forward effort to prevent disturbance on the overhead medium voltage distribution system. With a hand robotic, the strain clamp cover can be installed without turning off the 20 KV voltage, because the hand robotic is supported by a 3-meter long 20 KV stick, to support the minimum safe distance of more than 90 cm. The long distance between the worker's eyes and the object needs cameras for remote sensing installed in the robotic hand. This research examines the performance of programmed cameras supported by Wi-Fi data transmission and Arduino control performance supported by Bluetooth data transmission. The results of this study that has been carried out, is that the Esp32-Cam micro-controller hardware, which has been inserted by an IP camera, is able to provide a signal for the L298 DC motor controller to work properly. The test results show a very small latency an average of 20 milliseconds. So, this data transmission system is relatively reliable to operate hand robotic.

**Keywords:** Camera; programable; wi-fi; latency.

## 1. Introduction

The installation of the insulator cover on the strain clamp 20 KV system is done by a hand robotic is a forward effort to prevent disturbance on the overhead medium voltage distribution system. With a hand robotic, the strain clamp cover can be installed without


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turning off the 20 KV voltage, because the hand robotic is supported by a 3-meter long 20 KV stick, this hand robotic operates without connection between line to earth electrically so that workers can work in safe conditions without electric current flow accident.

To ensure the safety of workers from accidents due to the electric current flow, it is necessary to need a safe distance between workers and live parts. The distribution system has a higher voltage, and a longer distance needed of space clearance for safety. The minimum safe distance between workers and 15 Kilo Volt active equipment is 90 cm[1].

The distance between the worker's eyes to the object affects to difficulty for the worker to see the detail of the object being worked on. The higher the voltage, required longer the safe distance, the problem is the workers can not observe the object being worked on. To overcome this, a camera for remote sensing is installed in the hand robotic. To be able to see the objects captured by the camera, a monitor is needed near the workers. Data transmission from the camera to the monitor cannot be carried out using a physical cable, because there must be quite high resistance between the hand robotic and the operator. The minimum insulation between a human and an active voltage part for medium voltage is 100 Mega Ohms [2]. Insulation resistance 100 Mega Ohm, defense the maximum leakage current flow does not affect to the human body is 1 milli amperes maximum [3].

To keep the value of the insulation resistance of the 20 KV stick exceeding 100 mega ohms, data communication between the camera and monitor is carried out wirelessly via Wi-Fi, as well as the communication of the hand robotic control system is also carried out wirelessly using Bluetooth. Wi-Fi is one of the right channels for artificial intelligence because it is in the group of multi-carrier modulation (MCM) [4]. In one channel loaded multiple data without interference. This paper is an improvement on our previous paper, which presented the results of applied research that in order to operate the hand robotic to install the strain clamps cover requires two Android smartphones to monitor the captured of the two cameras. This paper will explain that viewing a monitor captured by two cameras is enough with one android smartphone.

## 2. Research Methode

### 2.1. Research Approaches and Concepts

This research is applied research, this research focuses on research to find solutions to simplicity operation of hand robotic to install the isolator cover. This study examines the efforts to simplify the communication and control of the hand robotic designed in previous research. This research simplifies three data communication with two android smartphones, via two Wi-Fi and one Bluetooth, to three data communications with 1 android smart phone via one Wi-Fi and one Bluetooth.

This research was conducted at the electrical engineering workshop of the Bali State Polytechnic and the State Electricity Company (PLN) Laboratory. This research was conducted by choosing a programmed camera to be installed on a hand robotic, while the control of the hand robotic mechanism was carried out based on Arduino. The two programmed cameras are communicated with the android smart phone via wi-fi, while the hand robotic controls via Bluetooth. The results of this study will be observed for the accuracy of work and the quality of the images presented on Android smart phones.

### 2.2. Total Samples

In this study, 100% samples were used from 3 hand robotic populations. Each operation will be tested one times, so a total of 23 data will be obtained. The data obtained is in the form of the time on latency camera sending the data to the android smart phone screen.

### 2.3. Variable Operational Definition

This study focuses to observed magnitude of the working is quality of image transferred by camera through wi-fi connection to smart phone android. To test the speed of sending images from the camera to the android smart phone screen, a latency test is performed. The unit of latency test results are measured in milliseconds.

### 2.4. Tested

In this study, two tests were carried out, on testing of the three hands robotic under live voltage 20 KV on over-head medium voltage distribution system. In each test condition, two observations were made, observation of the delay between the real moment to the viewing on the android smart phone screen, from this delay data is obtained about the latency of data transmission from the camera until it appears on the Android smartphone screen, this latency will be displayed in units of microseconds. All observations under 640x480 pixel video resolution were captured by the camera.

### 2.5. Data Analysis

In this study, data obtained from the test results are processed quantitatively. Data is processed mathematically by the process of multiplication, dividing, plus or minus. The data is also processed statistically by finding the smallest value from all of the data if the minimum, average, and maximum such as at time and resolution.

## 3. RESULT AND DISCUSSION

The results and discussion of this study are presented in figures, calculations, tables, and graphics. The hand robotic designed in this study is expected to operate well in the overhead distribution system without voltage or live voltage. physically this hand robotic can be presented in the photo below.

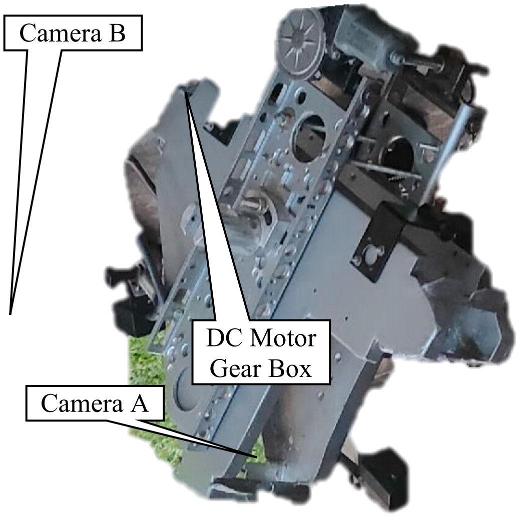


**Fig. 1.** Hand robotic

As shown in Figure 1, this research has given birth to a hand robotic that installs insulator clamps and pull-insulator clamps. This hand robotic is driven by a DC motor equipped with a gear box. To operate this motor, it is done with an Arduino motor driver, which is controlled in an Android smartphone with remote communication via Bluetooth.

The hand robotic, as presented in Figure 1, is equipped with two cameras. The video capture results of these two cameras are transmitted via the wi-fi facility to be displayed on the same Android smart phone to drive the robot's hand motor. The novelty of this applied research is the production of a program to drive and monitor the work of hand robotic only from an Android smart phone screen. The camera has been installed on this research as displayed at below.

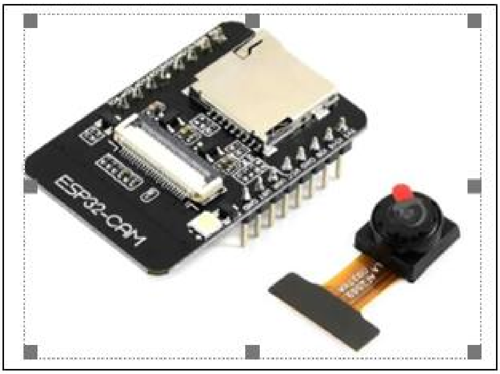


**Fig. 2.** Modul Esp32-Cam IP

The Esp32-Cam IP module is a modular camera (OV2640) that has been supported by Esp32, so that this camera can be programmed according to user needs. With this combination, it is possible to design control and monitoring systems. Such an imaging system provides user to control over the radiometric and geometric characteristics of the picture[5]. The small size of this camera also needs small space during installation. To operate the programmable Esp23-Cam camera, some hardware is required to be installed as shown below.

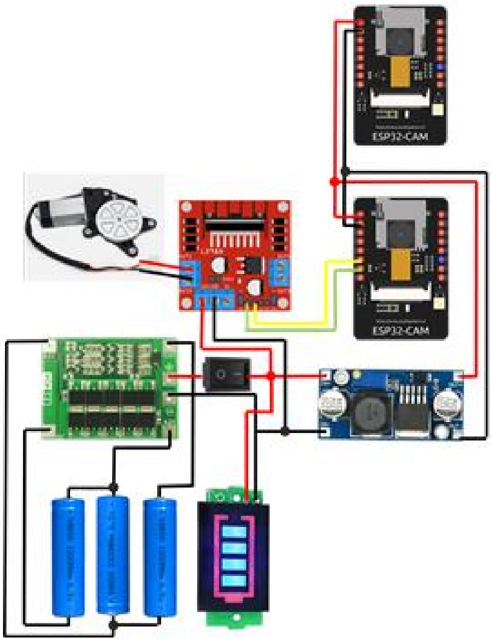


**Fig. 3.** Harware instalation

Based on fig. 3 can be describe There are 2 cameras mounted on the arm of the hand robotic. Camera A shoot at the installation position on the cable section. Camera B shoot to the top to monitor the installation on the isolator part. The control and monitoring system for the hand robotic uses 2 Esp32-Cams as microcontrollers and at the same time 2 cameras as monitoring. In the actuator part of the hand robotic, there is a 12 Volt DC motor equipped with a gearbox as a mechanical drive for the mechanical arm of hand robotic. This system is supplied by a 12 V DC power supply from series of 3 Li-ion battery cells with 3.7 V DC/each. This series of batteries uses a 3S Battery Management System (BMS) to maintain and protect battery damage due to overcharge and over discharge.

To provide power for the Esp32-Cam, a voltage step down is installed to 5V. The motor control system uses the L298 motor driver with the working principle of the H-bridge. The L298 driver will receive HIGH/LOW signals from the Esp32-Cam that go to pin number1 and pin number 2 on the L298 motor driver. This incoming signal will determine the direction of rotation of the DC motor. These two directions of rotation to move the hand robotic to opening or closing. To operate and monitor this hand robotic, a program is designed based on the system flowchart as shown in the figure below.

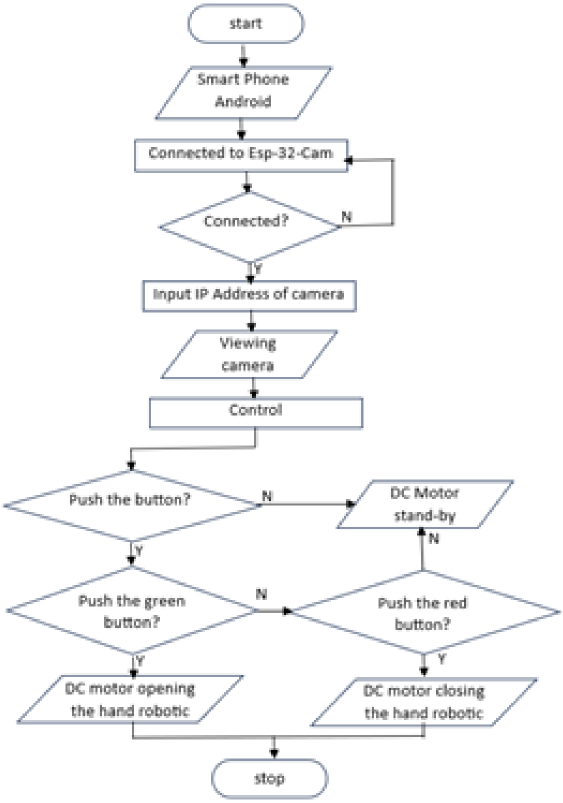


**Fig. 4.** Flowchart system hand robotic

Utilization of data transmission via wi-fi and Bluetooth in the hand robotic was chosen as a strategy to avoid electrical connection between the hand robotic and the operator. When the hand robotic is operated under the influence of an AC voltage of 20,000 volts, that voltage is very dangerous for humans. Despite the limited latency of wi-fi and Bluetooth, wi-fi is still an option, as long as the latency is within tolerance. When the risk level is unacceptable some countermeasure is required[6]. The value of latency is calculated by formula at below.

$$t1 - t2 = t \quad (1) \qquad a + b = c. \quad (1) \quad (1)$$

Remark:

*t1*: Real time stopwatch

*t2*: Displayed time on the smartphone android

τ : Latency (milli second)

### 3.1. Result

Evolved High Speed Packet Access (HSPA+) is a mobile telecommunication system technology, this technology an evolution of HSPA technology. This technology downlink speeds up to 21.1 Mbps and uplink speeds up to 11.5 Mbps on the bandwidth of 5MHz[7]. This technology is expected to fulfill and support the needs for information that involves all aspects of multimedia such as video and audio, especially live video streaming. The wi-fi network proposed protocol seemed to enhance the users' QoE[8].

All radio communication systems contain latency, likewise contains a probability distribution of the MAC packet latency, which is needed for small contention windows or very high operating loads and describes the standard deviation of the MAC packet latency[9]. Large load, will greatly affect to the latency of a data transmission. Wi-Fi latency follows a long tail distribution and the 90th (99th) percentile is around 20 ms (250 ms)[10]. In this study, the wi-fi loaded by the real load on the hand robotic, that are the video information captured by two cameras. This applied research was carried out with a fixed load with 2 cameras, so that the latency test was carried out very simply, with accurate results, as shown in the image below.

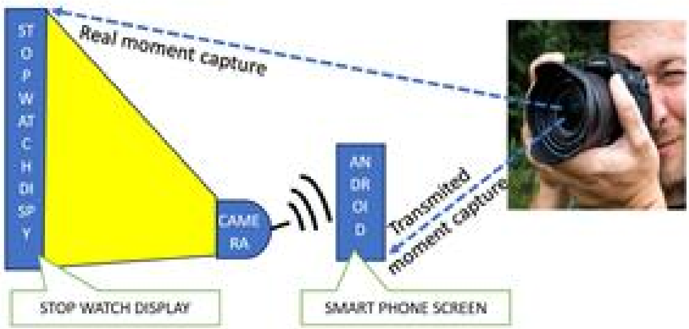


**Fig. 5.** Latency observation

Based on figure 5 above, it explains that latency observation is carried out by comparing the display of the react stopwatch which is counting forward with the capture stopwatch displayed on the smart phone screen. The stopwatch display is shown on a computer monitor, and the program stopwatch is displayed. The stopwatch displayed by the computer screen is captured by the camera (Esp32-Cam IP Module). The Esp32-Cam IP module is a module camera (OV2640) that has been supported by Esp32, the operation of this camera can be programmed according to user needs. The camera capture data are transmitted by Esp32 via a wi-fi wave to the android smart phone, which is then displayed on the smart phone screen. The stopwatch numbers displayed by the computer monitor and the smartphone screen are placed close together so that a digital camera capture them in one shot. An image of two numbers stop watch captured by digital camera as shown in the figure at below.

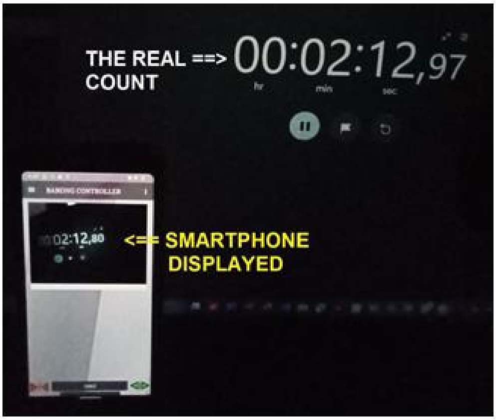


**Fig. 6.** Latency camera A

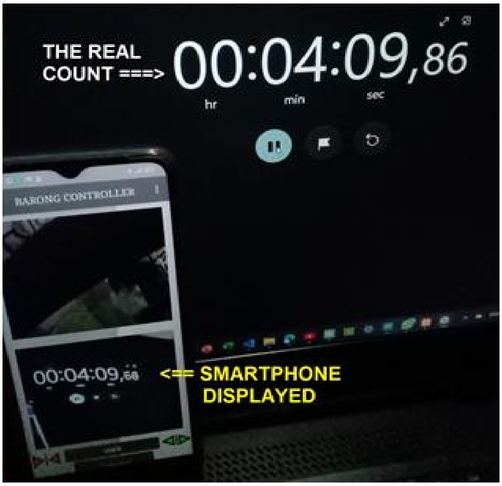


**Fig. 7.** Latency Camera B

Based on the results of observations on the latency of data transmission from the Esp32-Cam camera programmable, in a very simple applied way the observed data can be presented as presented in the table below.

TABLE I. LATENCY DATA OBSERVATION

| **CAM ERA** | **TIME STOPWATCH** | |
|---|---|---|
| | ***Real count*** | ***Smartphone displayed*** |
| A&B | 00:48:27,82 | 00:48:27,64 |
| A&B | 00:48:32,47 | 00:48:32,28 |
| A&B | 00:48:34,41 | 00:48:34,24 |
| A&B | 00:48:35,33 | 00:48:35,11 |
| A&B | 00:48:37,16 | 00:48:36,94 |
| A&B | 00:48:40,82 | 00:48:40,65 |
| A&B | 00:48:44,54 | 00:48:44,35 |
| A&B | 00:48:47,82 | 00:48:47,62 |
| A&B | 00:48:48,84 | 00:48:48,67 |
| A&B | 00:48:50,95 | 00:48:50,74 |
| A&B | 00:48:54,91 | 00:48:54,70 |
| A&B | 00:48:55,94 | 00:48:55,72 |
| A&B | 00:49:03,06 | 00:49:02,89 |
| A&B | 00:49:04,41 | 00:49:04,21 |
| A&B | 00:49:05,41 | 00:49:05,23 |
| A&B | 00:49:06,40 | 00:49:06,22 |
| A&B | 00:49:08,38 | 00:49:08,16 |
| A&B | 00:49:09,31 | 00:49:09,09 |
| A&B | 00:49:10,25 | 00:49:10,08 |
| A&B | 00:49:11,21 | 00:49:11,02 |
| A&B | 00:49:13,03 | 00:49:12,83 |
| A&B | 00:49:16,31 | 00:49:16,08 |
| A&B | 00:49:17,40 | 00:49:17,22 |

## 3.2. Discussion

Based on the observed data as shown in table I, a mathematical and statistical analysis was carried out. By using formula (1), the latency value is calculated mathematically like the example below.

$t1$: 00:48:27,82

$t2$: 00:48:27,64

$\tau$ = 00:48:27,82 - 00:48:27,64

= 00,18 milli second

Through the same calculation method, the latency value is obtained as shown in the table below. The latency values statistically processed to obtain the values of the mode, median, average, maximum, minimum and standard deviation.

TABLE II. LATENCY DATA ANALYSIS

| **CAMERA** | **TIME STOPWATCH** | | **LATENCY** |
|---|---|---|---|
| | ***Real count*** | ***Smartphone displayed*** | ***(second)*** |
| A&B | 00:48:27,82 | 00:48:27,64 | 00,18 |
| A&B | 00:48:32,47 | 00:48:32,28 | 00,19 |
| A&B | 00:48:34,41 | 00:48:34,24 | 00,17 |
| A&B | 00:48:35,33 | 00:48:35,11 | 00,22 |
| A&B | 00:48:37,16 | 00:48:36,94 | 00,22 |
| A&B | 00:48:40,82 | 00:48:40,65 | 00,17 |
| A&B | 00:48:44,54 | 00:48:44,35 | 00,19 |
| A&B | 00:48:47,82 | 00:48:47,62 | 00,20 |
| A&B | 00:48:48,84 | 00:48:48,67 | 00,17 |
| A&B | 00:48:50,95 | 00:48:50,74 | 00,21 |
| A&B | 00:48:54,91 | 00:48:54,70 | 00,21 |
| A&B | 00:48:55,94 | 00:48:55,72 | 00,22 |
| A&B | 00:49:03,06 | 00:49:02,89 | 00,17 |
| A&B | 00:49:04,41 | 00:49:04,21 | 00,20 |
| A&B | 00:49:05,41 | 00:49:05,23 | 00,18 |
| A&B | 00:49:06,40 | 00:49:06,22 | 00,18 |
| A&B | 00:49:08,38 | 00:49:08,16 | 00,22 |
| A&B | 00:49:09,31 | 00:49:09,09 | 00,22 |
| A&B | 00:49:10,25 | 00:49:10,08 | 00,17 |
| A&B | 00:49:11,21 | 00:49:11,02 | 00,19 |
| A&B | 00:49:13,03 | 00:49:12,83 | 00,20 |
| A&B | 00:49:16,31 | 00:49:16,08 | 00,23 |
| A&B | 00:49:17,40 | 00:49:17,22 | 00,18 |
| | MODUS | | 00,17 |
| | MEDIAN | | 00,19 |
| | AVERAGE | | 00,20 |
| | MAXIMUM | | 00,23 |
| | MINIMUM | | 00,17 |
| | STANDARD DEVIATION | | 2,33758E-07 |

The data in Table II above shows that, the latency value of the Esp32-Cam module inserted in the camera is a minimum of 17 milliseconds, a maximum of 23 milliseconds, the mode is 17 milliseconds, the average latency value is 20 milliseconds. These values indicate that the latency value is still relatively low because it is under 1 second. The very small standard deviation value of only 2.34 x 10-5 milliseconds explains that the accuracy of the data contained in table II is very good. In simple terms, the data can be presented in the chart below.

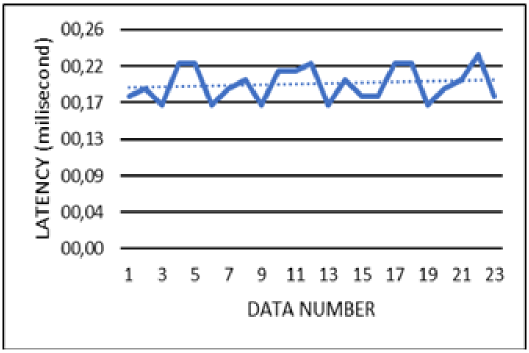


**Fig. 8.** Latency chart

Fig. 8 displays information that the programmable latency value of the camera module type Esp32-Cam has good latency because the value is below 1 second. The figure also displays a dotted line depicting a trend line that tends to increase, but the value is not significant, because the trend line only shows the numbers 20 to 21 milliseconds.

## 4. Conclusion and Sugestion

### 4.1. Conclusion

Based on the results of the hardware design and data analysis that has been carried out, it shows that the Esp32-Cam micro-controller hardware, which has been inserted by an IP camera, is able to provide a signal to the L298 DC motor controller to work properly. The test results show a very small latency with a higher value of 23 milliseconds, even the smallest value is 17 milliseconds in average 20 millisecond. So, this data transmission system is relatively reliable to operate hand robotic.

### 4.2. Suggestion

Based on the data and results of this study, there are several suggestions that can be submitted, such as: To the State Electricity Company (PLN) to use this hand robotic, the hand robotic is a tool in a live line voltage, because workers are not connected to electricity and the operation is carried out through bluetooth and wi-fi, which are now easier to operate and monitor just in one android smart phone device; To the next researchers, this research still has the opportunity to be developed and simplified how to operate so that it is easier to operate.

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